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PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Ion-Exchange apparatus and processes

We, THE PERMUTIT COMPANY LIMITED, a British Company, of Permutit House, Gunnersbury Avenue, London, W.4, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

In the operation of an ion-exchange process by passage of a liquid through a bed of ion-exchange material, it is necessary from time to time to regenerate the bed by the passage of a regenerant liquid through it. In practice, the flow of the liquid under treatment is usually downwards through the bed. When the bed must be regenerated, it is always first back-washed by upward flow of liquid to remove entrapped impurities, and then in practice it is regenerated by downward flow. Thereafter the bed is rinsed downwardly before service flow begins again.

It is well established that such downward regeneration is inefficient because the fresh regenerant comes into contact with the top of the bed and by the time it reaches the bottom it is no longer in the best condition for regeneration. As a result the quality of the treated liquid leaving the bed in the subsequent service run is not as good as it might be.

Various proposals have been made for effecting regeneration in countercurrent, but conventional regeneration is the more usual despite its disadvantages.

According to the invention a closed vessel containing (but not filled by) a bed of ion-exchange material is divided into a central space and a surrounding space by a tube which extends downwardly from the top of the vessel but which stops short of the bottom of the vessel. Strainers which allow water but not the ion-exchange material to pass and which may be of any of the well-known kinds are provided in the upper part of each space. The

vessel has passages for the flow of liquid into it, through the strainers in the spaces in either direction and out of it.

As a result flow of liquid through the bed can take place either downwards through the central space and then upwards through the surrounding space to leave at the top, or vice versa, the tube being partly or wholly filled with resin depending on the direction of flow of the liquid.

A vessel holding a bed of ion-exchange material is commonly cylindrical. Inside a cylindrical vessel the central tube should be coaxial with the vessel and of circular cross-section. It may be cylindrical, but preferably is frusto-conical widening downwardly.

The invention may be used with beds of cation-exchange or anion-exchange materials. It is most advantageously used when these materials are resin beads because beds of such beads most easily move as a whole.

The preferred vessel according to the invention will now be described by way of example with reference to the accompanying diagrammatic drawing, in which Figure 1 shows the vessel and various pipe connections to it with the bed in the position it takes up during service flow, and Figure 2 shows the vessel alone with the bed in the position it takes up during regeneration.

The drawing shows a cylindrical vessel 1 of the kind used in ion-exchange processes, with a central frusto-conical tube 2 extending downwards from the top of the vessel to a point above the bottom. The vessel is thus divided into a central space 3 of circular cross-section and a surrounding annular space 4.

In the upper part of the central space 3 there is a flat plate 5 which spans the tube 2 and in which strainers 6 of the kind that allow water but not ion-exchange material to pass are mounted. The plate 5 thus divides the space 3 into two, of which the upper is

an inlet or outlet space 7. A passage for the flow of liquid to or from this space 7 is formed in a fitting 8 at the top of the vessel.

In the other part of the annular space 4 there is a pipe 9 which runs from a fitting 10 in the wall of the vessel and extends in a nearly complete circle round the space 4. The inner end of this pipe is closed, and it carries strainers 11.

The vessel is charged with ion-exchange beads shown by cross-hatching.

With the apparatus according to the invention countercurrent regeneration becomes simple. While the bed is being used for the treatment of liquid, say water, this liquid is supplied through a pipe 12 through the fitting 10 to the pipe 9 to flow down through the annular space 4 and upwards through the central space 3, leaving through the fitting 8 and a pipe 13. During this service flow the ion-exchange beads press against the underside of the plate 5 as shown in Figure 1. The bed is thus in a considerable state of compression. This is well known to be desirable in order to avoid channelling in the bed with the risk that liquid will flow through the bed without making adequate contact with the ion-exchange material.

When the bed requires regeneration it is backwashed by water introduced through a pipe 14, and the bed is moved as a whole in the direction of flow to press against the top of the vessel as shown in Figure 2.

At the end of the backwashing step regenerating liquid is introduced through the pipe 14 and fitting 8 to flow in the same way as the backwashing water.

When all the regeneration liquid has been introduced the bed is rinsed. Advantageously most of the rinsing liquid flows in the same direction as the regenerating liquid, that is to say it is introduced through the pipe 14 and leaves through the fitting 10 and pipe 15. However it is desirable to cause a small proportion of the rinsing liquid to flow in the reverse direction, that is to say to introduce it through the pipe 12 and fitting 10, and discharge it through a pipe 16 to drain. During the flow of this part of the rinsing liquid, the bed will move as a whole to be ready for the treatment of future liquid.

As the liquid flows under the edge of the tube 2 in either direction, it may happen that little if any of it actually passes through the part of the bed that lies on and just above the bottom of the vessel. Some of this part of the bed may even not move on each reversal of flow. To avoid this waste of capacity, the bottom of the vessel is covered by a conical insert 17.

Alternatively the bottom of the vessel may be domed.

Instead of providing the strainers at the top of the annular space on a pipe such as that shown at 9, they may be mounted in

a flat plate that spans the annular space and that conveniently may be the same as the plate that spans the central tube; and a passage for the flow of liquid to or from the space above this annular plate for the annular part of a single plate, may then be formed in the top or the side wall of the vessel. In this case of course the bed will be pressed against the underside of this annular flat plate when the flow is upwards through the annular space.

WHAT WE CLAIM IS:—

1. A closed vessel containing (but not filled by) a bed of ion-exchange material and divided into a central space and a surrounding space by a tube which extends downwardly from the top of the vessel but which stops short of the bottom of the vessel, strainers which allow water but not the ion-exchange material to pass being provided in the upper part of each space and the vessel having passages for the flow of liquid into it, through the strainers in the spaces in either direction and out of the vessel, whereby flow of liquid through the bed can take place either downwards through the central space and then upwards through the surrounding space to leave at the top, or *vice versa*, the tube being partly or wholly filled with resin depending on the direction of flow of the liquid.

2. A closed cylindrical vessel containing (but not filled by) a bed of ion-exchange material and divided into a central and a surrounding annular space by a frusto-conical tube that is coaxial with the vessel, extends and widens downwardly from the top of the vessel but stops short of the bottom of the vessel, strainers which allow water but not the ion-exchange material to pass being provided in the upper part of each space and the vessel having passages for the flow of liquid into it, through the strainers in the spaces in either direction and out of the vessel, whereby flow of liquid through the bed can take place either downwards through the central space and then upwards through the surrounding space to leave at the top, or *vice versa*, the tube being partly or wholly filled with resin depending on the direction of flow of the liquid.

3. A closed vessel according to claim 1 or claim 2 in which the strainers at the top of the central space are mounted in a flat plate that spans the tube below the top of the vessel so as to form with the top of the vessel an inlet or outlet space, the passage for the flow of liquid into the vessel to pass through this space being formed in the top of the vessel.

4. A closed vessel according to any preceding claim in which the strainers at the top of the surrounding space are on a pipe that extends round the space close to the top of the vessel, and that passes through the wall of the vessel or is connected to an opening in the wall.

5. A closed vessel according to any preceding

ing claim in which the bottom of the vessel is domed or covered by a conical insert.

5 6 A closed vessel according to claim 2 substantially as described with reference to the accompanying diagrammatic drawings.

10 7 An ion-exchange process for the treatment of liquid carried on in a closed vessel according to any preceding claim with periodical regeneration in countercurrent to the flow during the treatment.

8 A process according to claim 7 in which after being regenerated the bed is first rinsed by rinsing liquid flowing in the same direction as the regenerating liquid, and thereafter the flow of rinsing liquid is reversed. 15

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COMPLETE SPECIFICATION

1 SHEET

This drawing is a reproduction of
the Original on a reduced scale

